Linking Excessive Heat with Daily Heat-Related Mortality over the Coterminous United States

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In the United States, extreme heat is the most deadly weather-related hazard. In the face of a warming climate and urbanization, which contributes to local-scale urban heat islands, it is very likely that extreme heat events (EHEs) will become more common and more severe in the U.S. This research seeks to provide historical and future measures of climate-driven extreme heat events to enable assessments of the impacts of heat on public health over the coterminous U.S. We use atmospheric temperature and humidity information from meteorological reanalysis and from Global Climate Models (GCMs) to provide data on past and future heat events. The focus of research is on providing assessments of the magnitude, frequency and geographic distribution of extreme heat in the U.S. to facilitate public health studies. In our approach, long-term climate change is captured with GCM outputs, and the temporal and spatial characteristics of short-term extremes are represented by the reanalysis data.

Two future time horizons for 2040 and 2090 are compared to the recent past period of 1981-2000. We characterize regional-scale temperature and humidity conditions using GCM outputs for two climate change scenarios (A2 and A1B) defined in the Special Report on Emissions Scenarios (SRES). For each future period, 20 years of multi-model GCM outputs are analyzed to develop a 'heat stress climatology' based on statistics of extreme heat indicators. Differences between the two future and the past period are used to define temperature and humidity changes on a monthly time scale and regional spatial scale. These changes are combined with the historical meteorological data, which is hourly and at a spatial scale (12 km) much finer than that of GCMs, to create future climate realizations. From these realizations, we compute the daily heat stress measures and related spatially-specific climatological fields, such as the mean annual number of days above certain thresholds of maximum and minimum air temperatures, heat indices, and a new heat stress variable developed as part of this research that gives an integrated measure of heat stress (and relief) over the course of a day. Comparisons are made between projected (2040 and 2090) and past (1990) heat stress statistics. Outputs are aggregated to the county level, which is a popular scale of analysis for public health interests. County-level statistics are made available to public health researchers by the Centers for Disease Control and Prevention (CDC) via the Wide-ranging Online Data for Epidemiologic Research (WONDER) system. This addition of heat stress measures to CDC WONDER allows decision and policy makers to assess the impact of alternative approaches to optimize the public health response to EHEs. Through CDC WONDER, users are able to spatially and temporally query public health and heat-related data sets and create county-level maps and statistical charts of such data across the coterminous U.S.